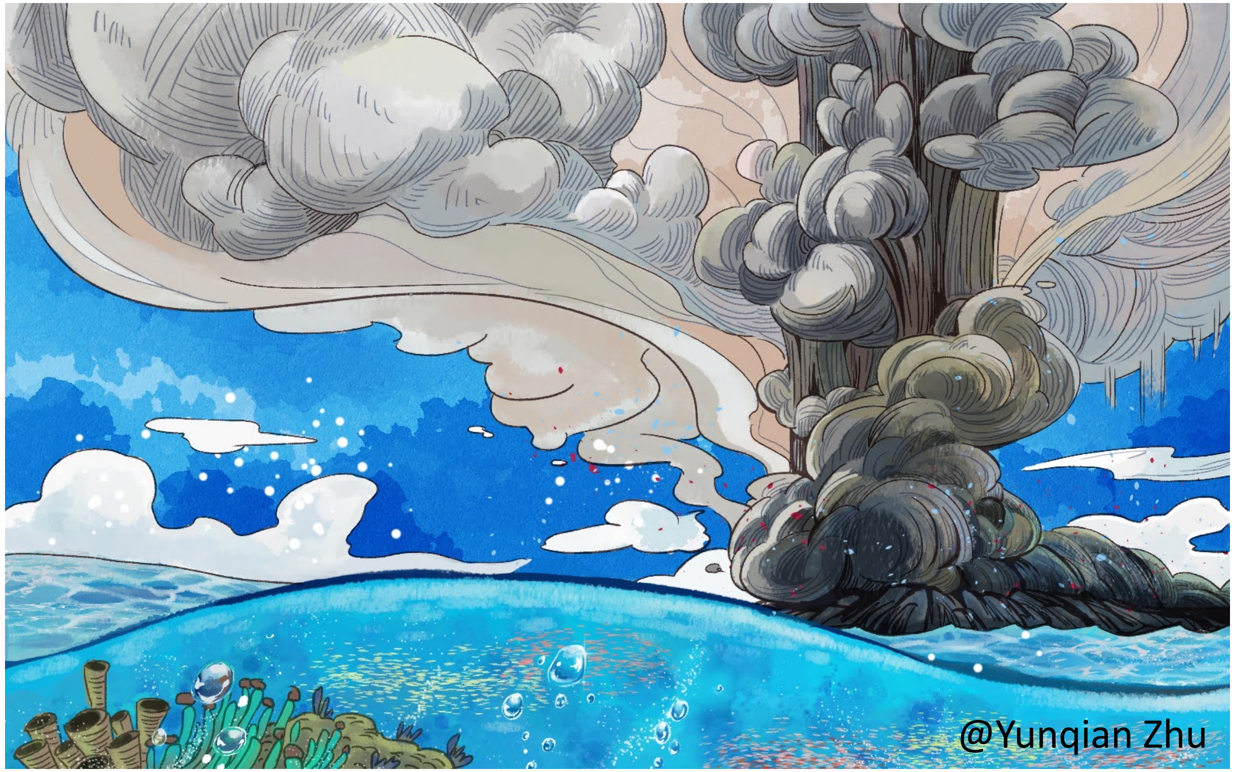
Observing Hunga Tonga stratospheric H_2O from SAGE III/ISS



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Thanks to: Xinyue Wang, U. Colorado

Overview:

- HTHH eruption in January 2022 caused persistent stratospheric H_2O and aerosol plumes, and caused large impacts on temperature, circulation and ozone

- This work: compare H_2O observations among SAGE III/ISS, MLS, ACE-FTS

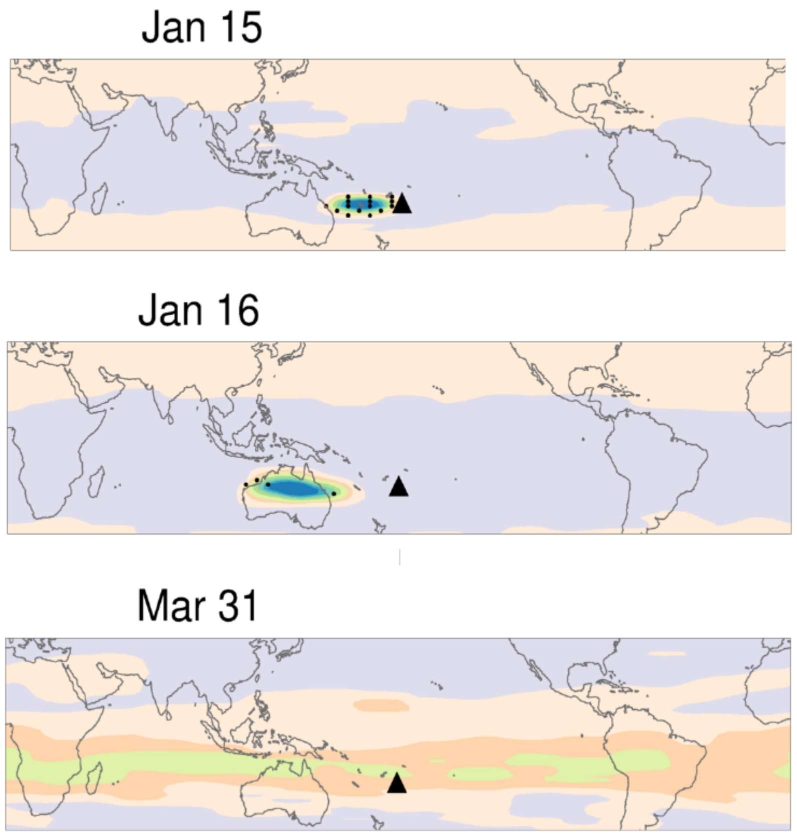
Data:

SAGE III/ISS v5.3	solar occultation (uv)	2017-present
MLS v4.2 and v5.0	limb emission	2004-present
ACE-FTS v5.3	solar occultation (IR)	2004-present

Hunga Tonga H_2O plume from MLS observations

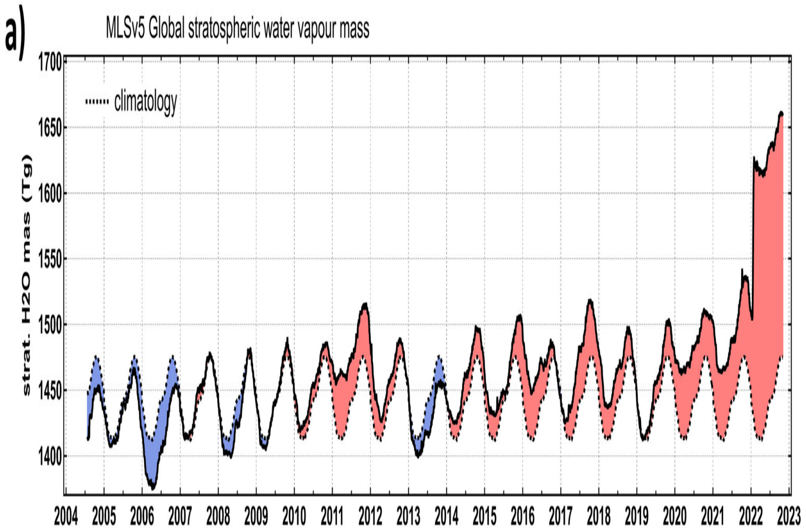
MLS v4.2

Estimated mass: 146 Tg
~ 10 % of global stratospheric burden



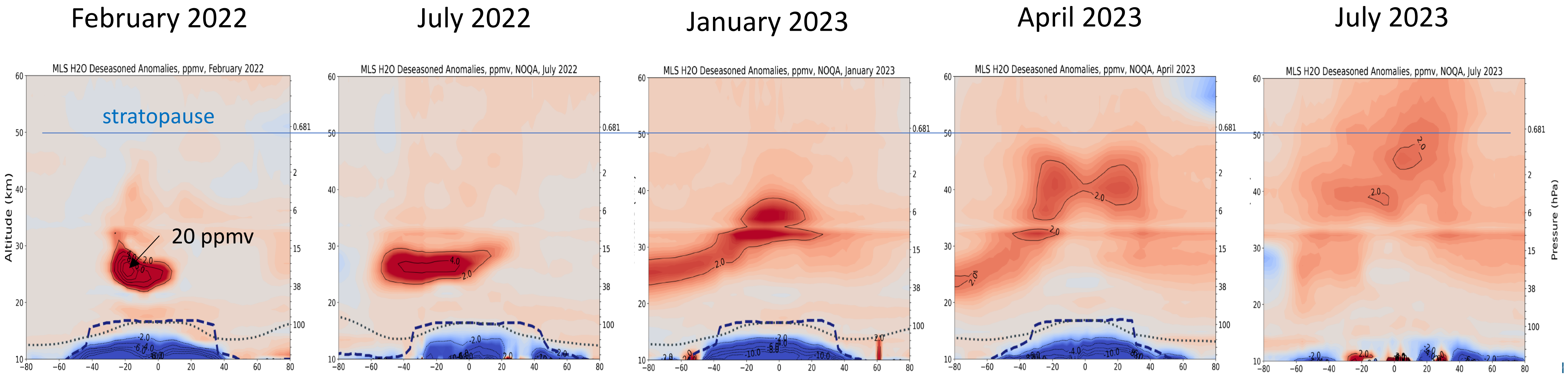
Milan et al 2022, GRL

MLS v5.0 data: 119 Tg



Khaykin et al 2022

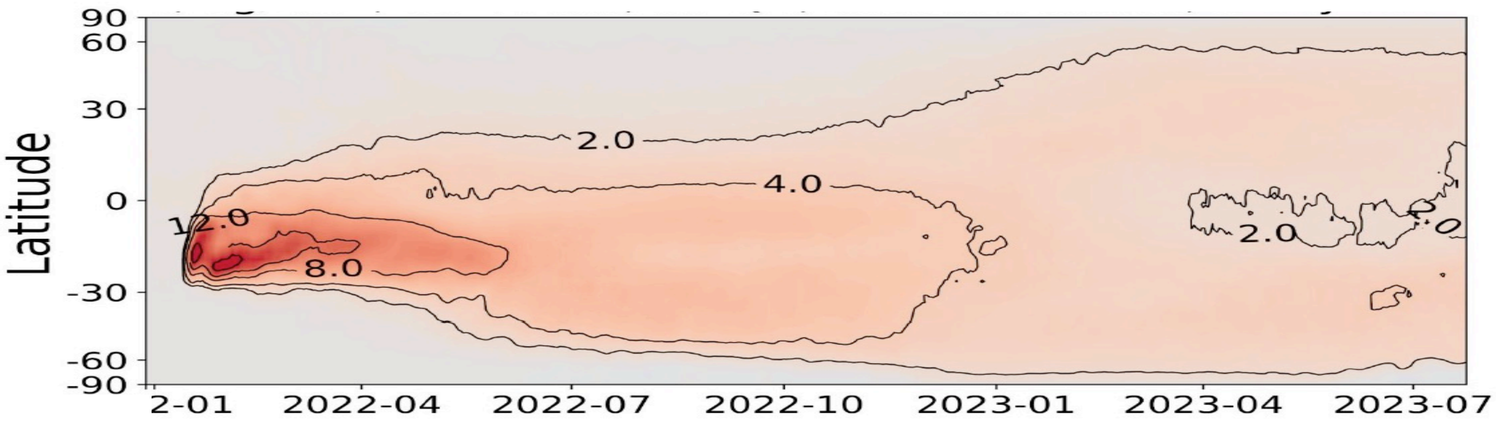
Evolution of Hunga Tonga H_2O plume from MLS v5.0



Anomalies calculated as differences from 2017-2021 background seasonal cycle

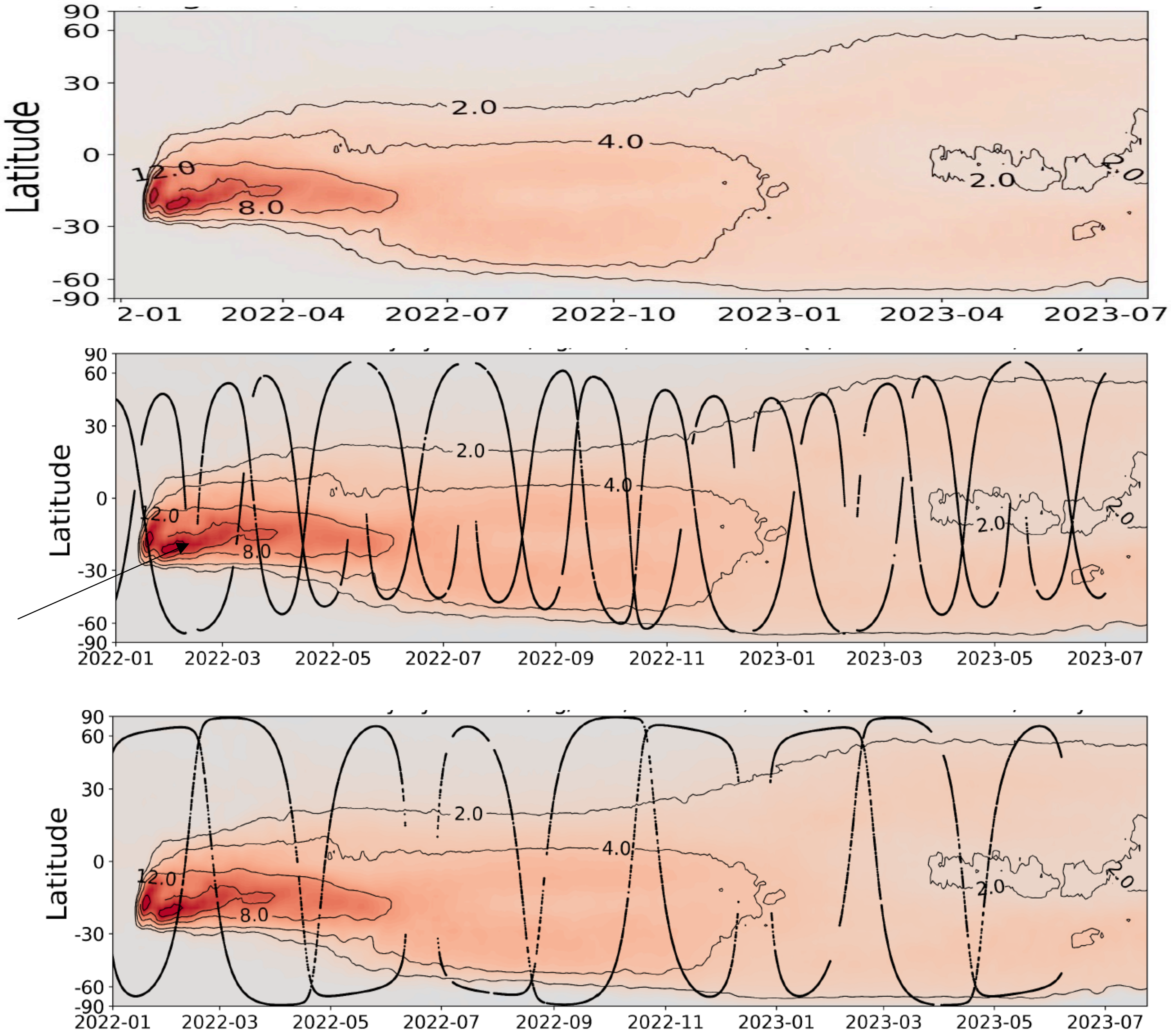
Stratospheric background H_2O is ~ 5 ppmv

H_2O mass anomaly
Tg / 2.5° 16-48 km



MLS

H_2O mass anomaly
Tg / 2.5° 16-48 km



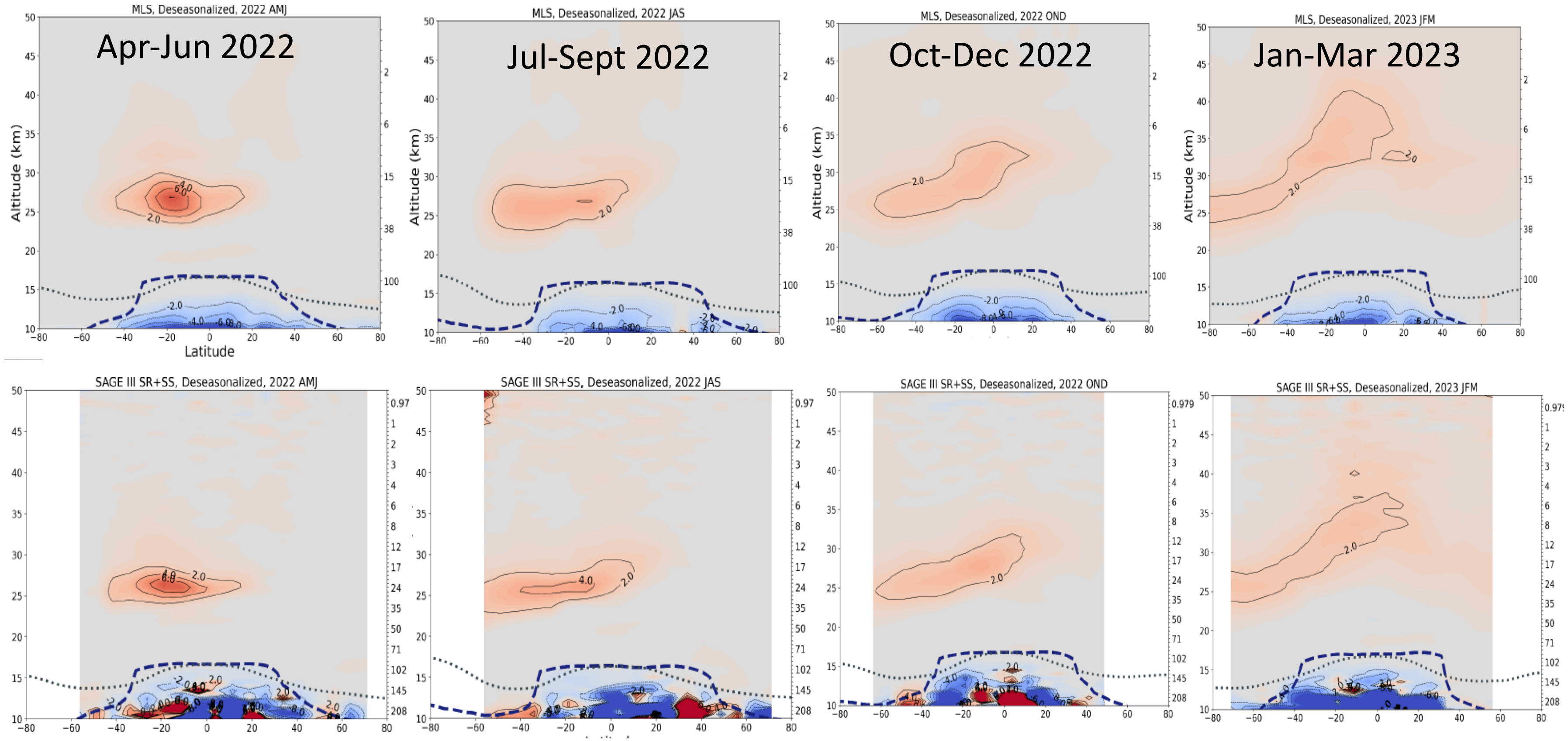
MLS

SAGE III/ISS sampling

ACE-FTS sampling

SAGE III/ISS misses much of the early plume

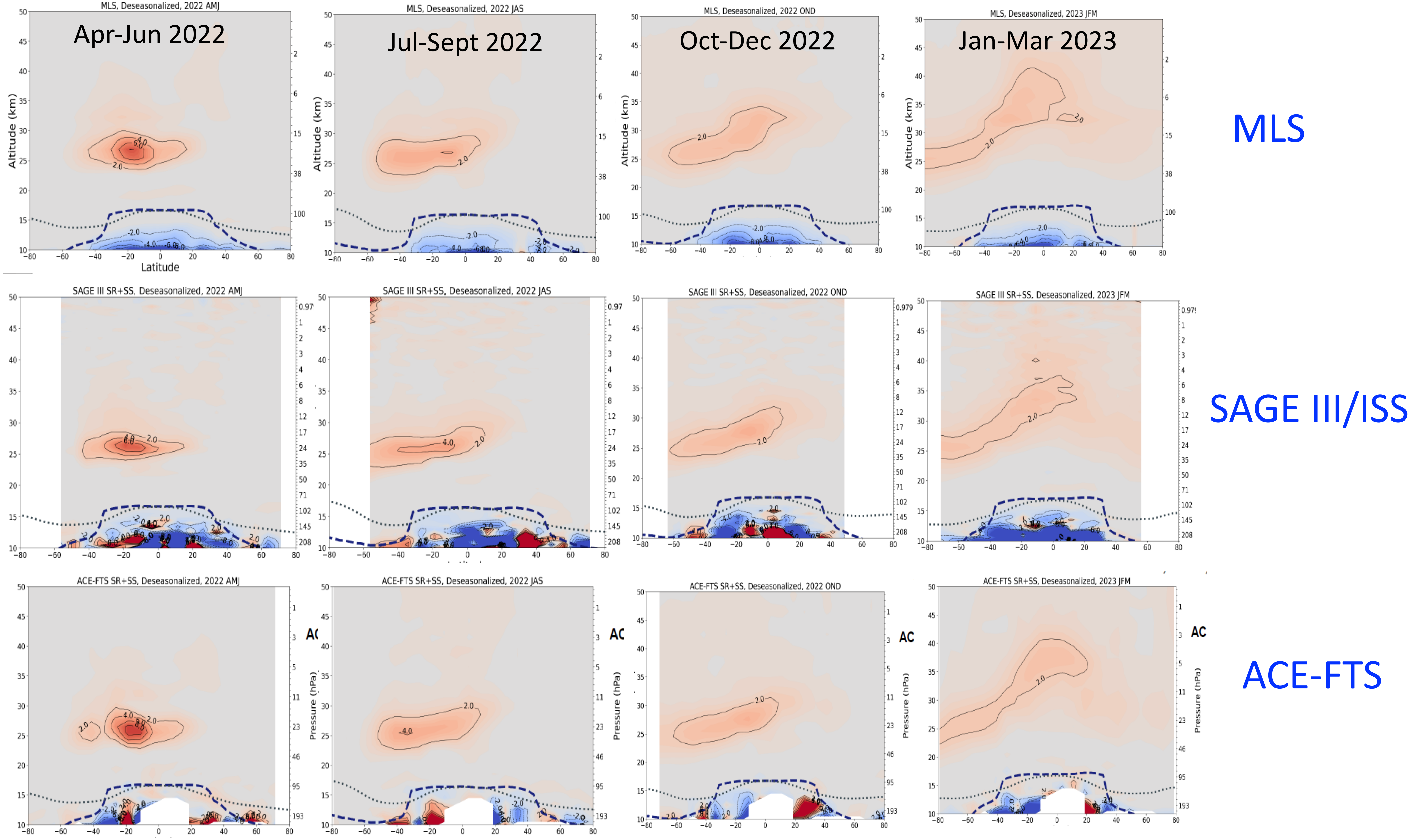
H_2O anomalies (ppmv)



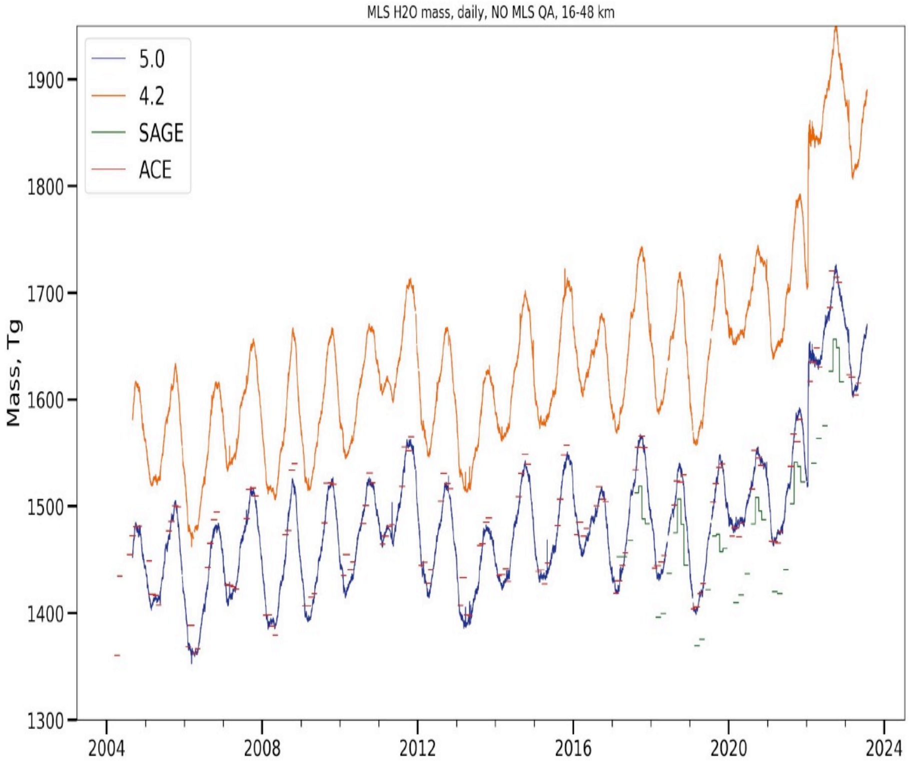
MLS

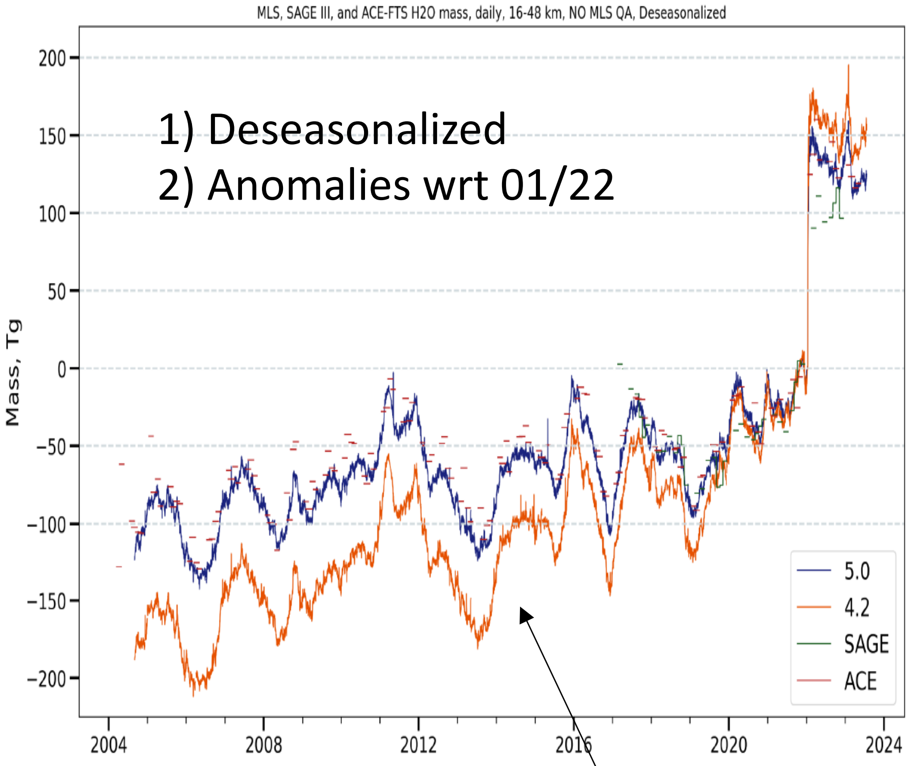
SAGE III/ISS

H_2O anomalies (ppmv)



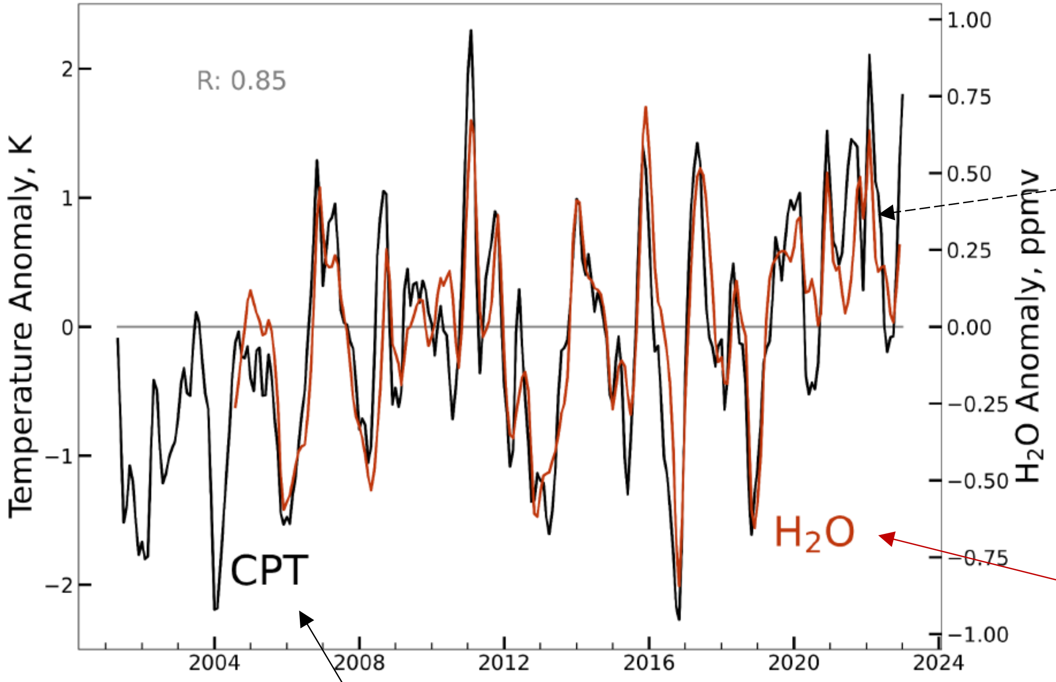
Near-global stratospheric H_2O mass   100-1 hPa (16-48 km)





drift in MLS v4.2
Livesey et al 2021

Interannual H_2O changes linked to tropical cold point tropopause

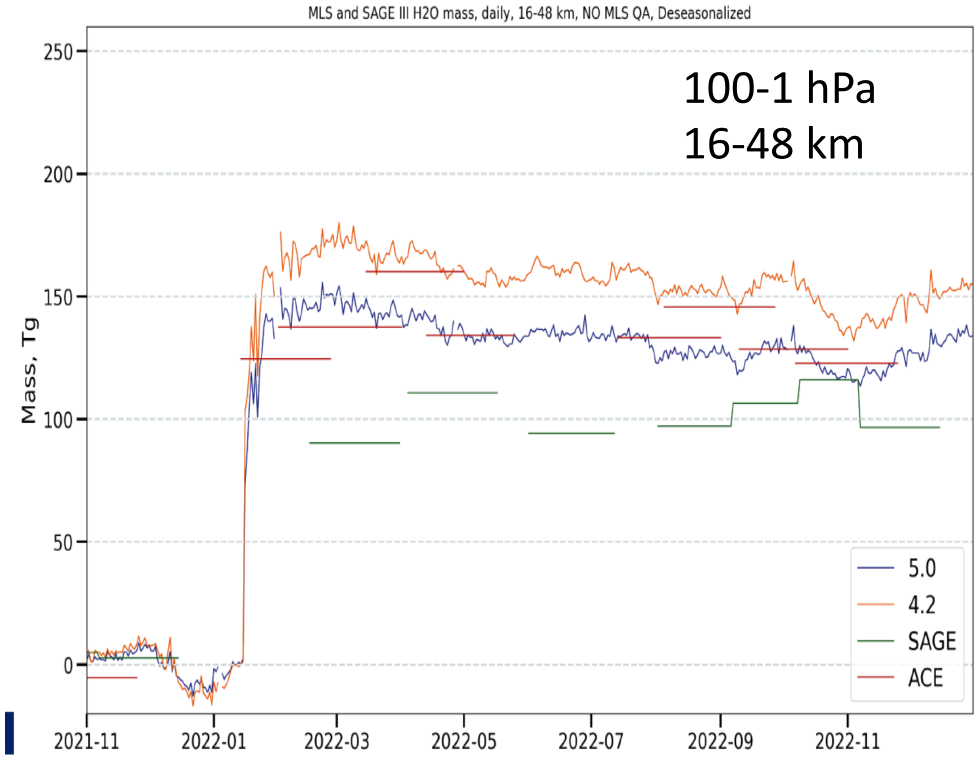


Warm CPT from 3 consecutive La Nina events 2020-2023

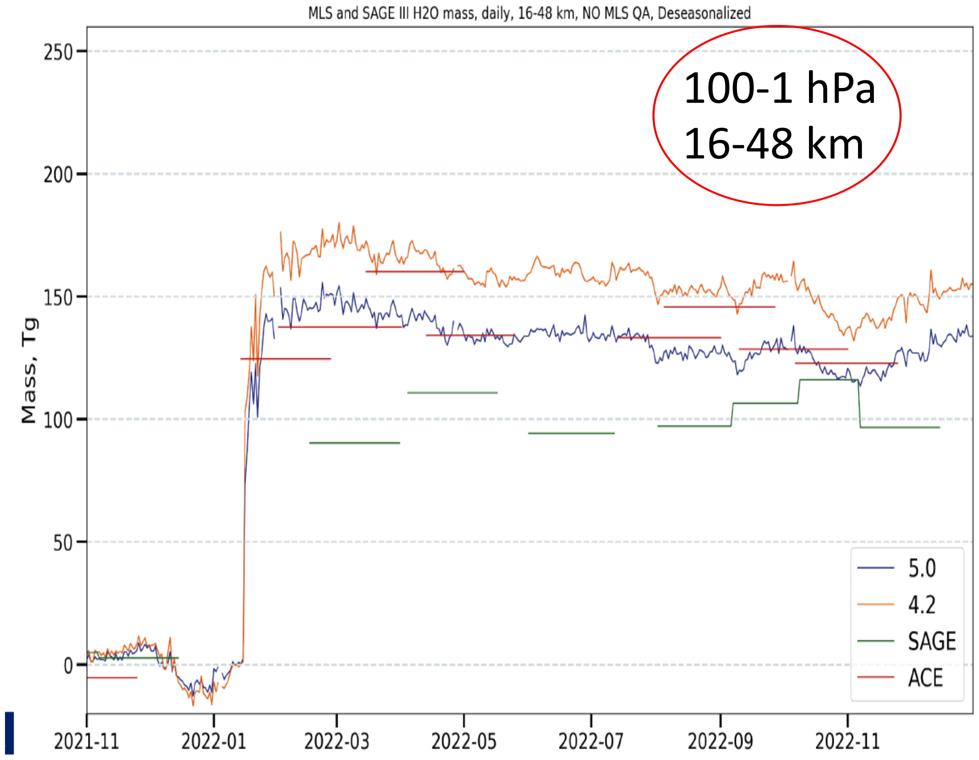
83 hPa 10^{o} N-S MLS v5.0

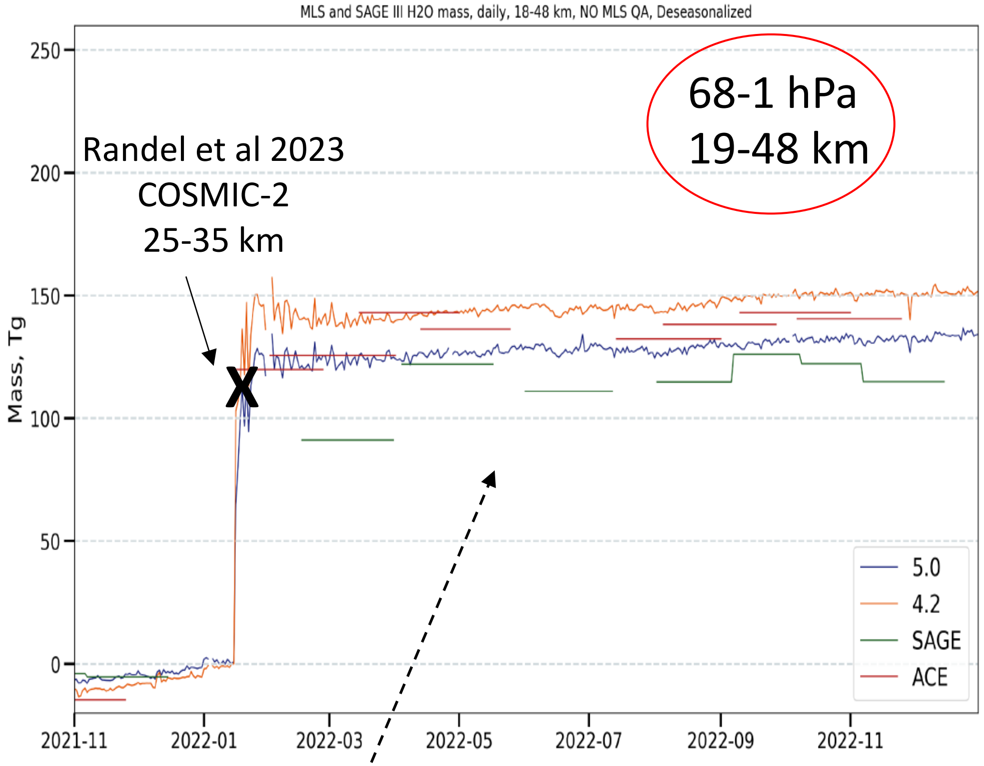
Radio occultation cold point tropopause

Deseasonalized anomalies: zoom-in on 2022



Deseasonalized anomalies: zoom-in on 2022



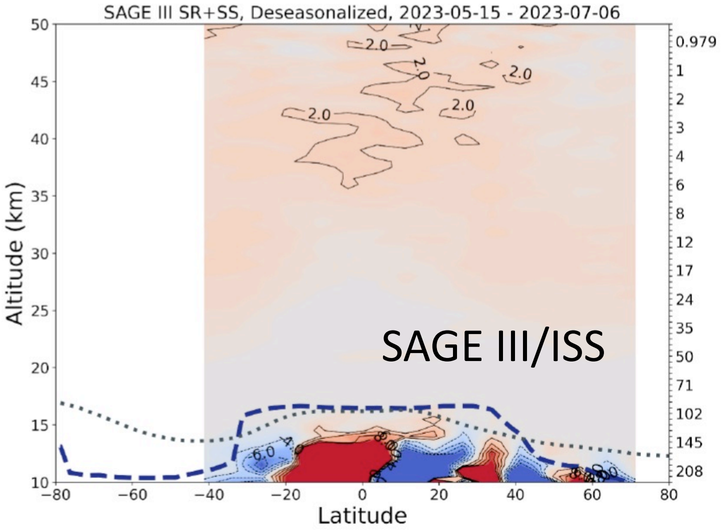


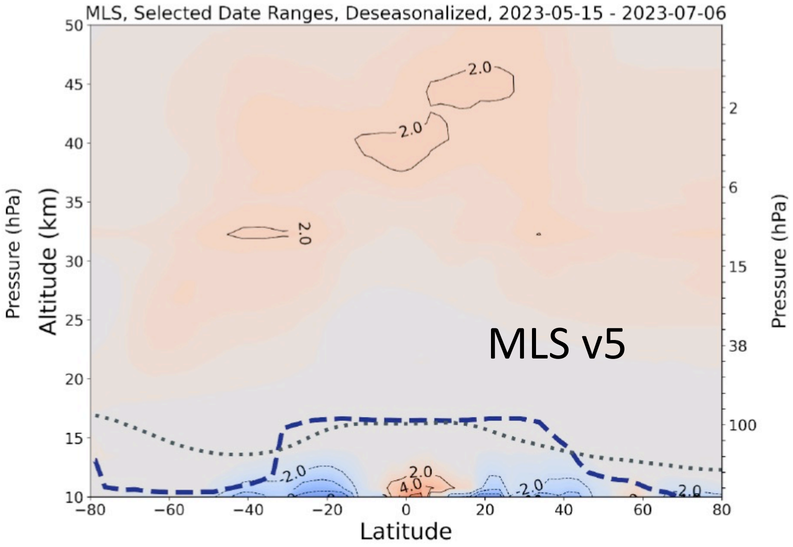
2022 averages:	SAGE III/ISS	113 Tg
	MLS (v5/v4)	127 (145) Tg
	ACE-FTS	137 Tg

Take-away points:

- Good agreement on H_2O plume evolution among SAGE III/ISS, MLS and ACE-FTS
- Plume globally dispersed, approximately constant H_2O mass anomalies over time.
- Honga Tonga H_2O mass ~120-140 Tg

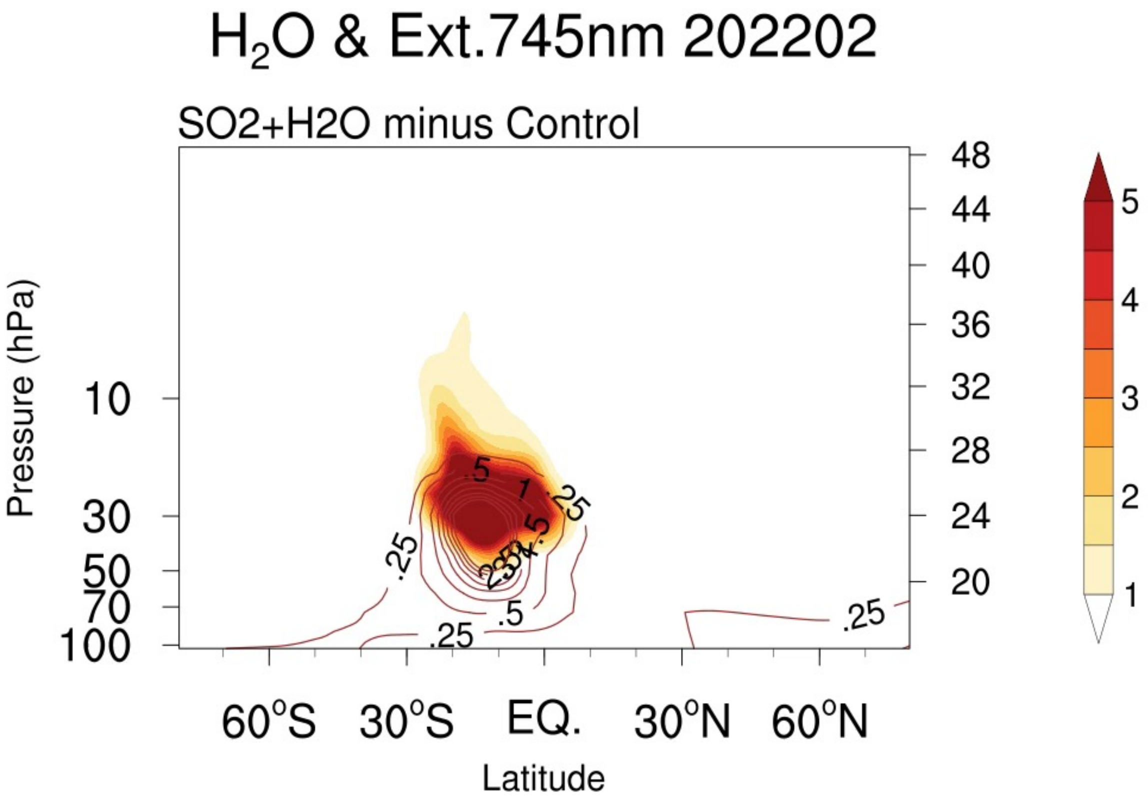
H_2O anomalies
May 15 – July 6, 2023



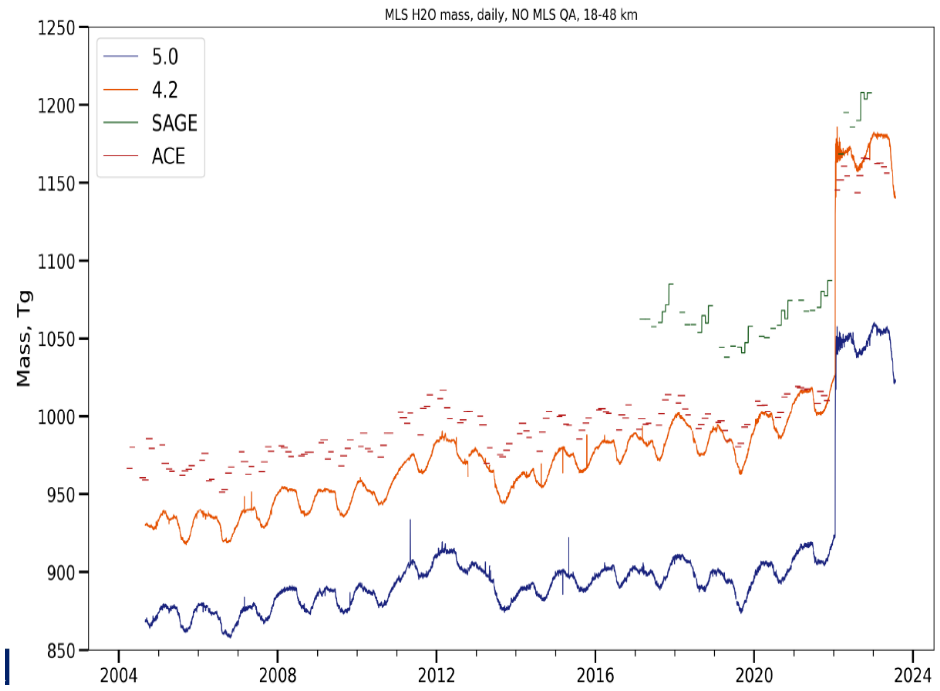


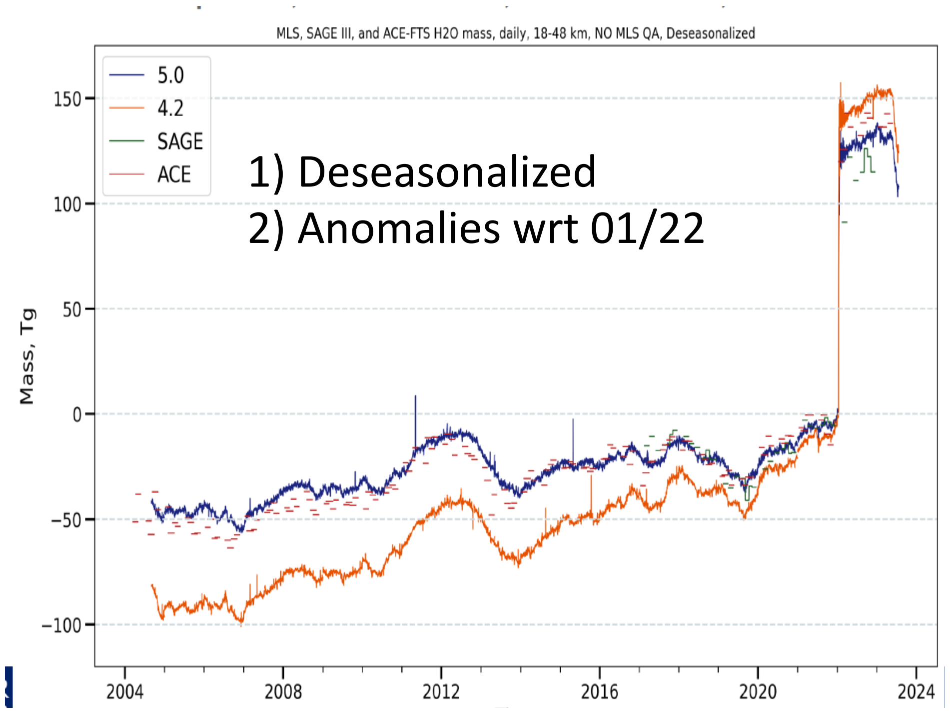
WACCM simulation of Tonga H_2O and aerosol plumes

From Xinyue Wang, U. Colorado



Near-global stratospheric H_2O mass 68-1 hPa (19-48 km)



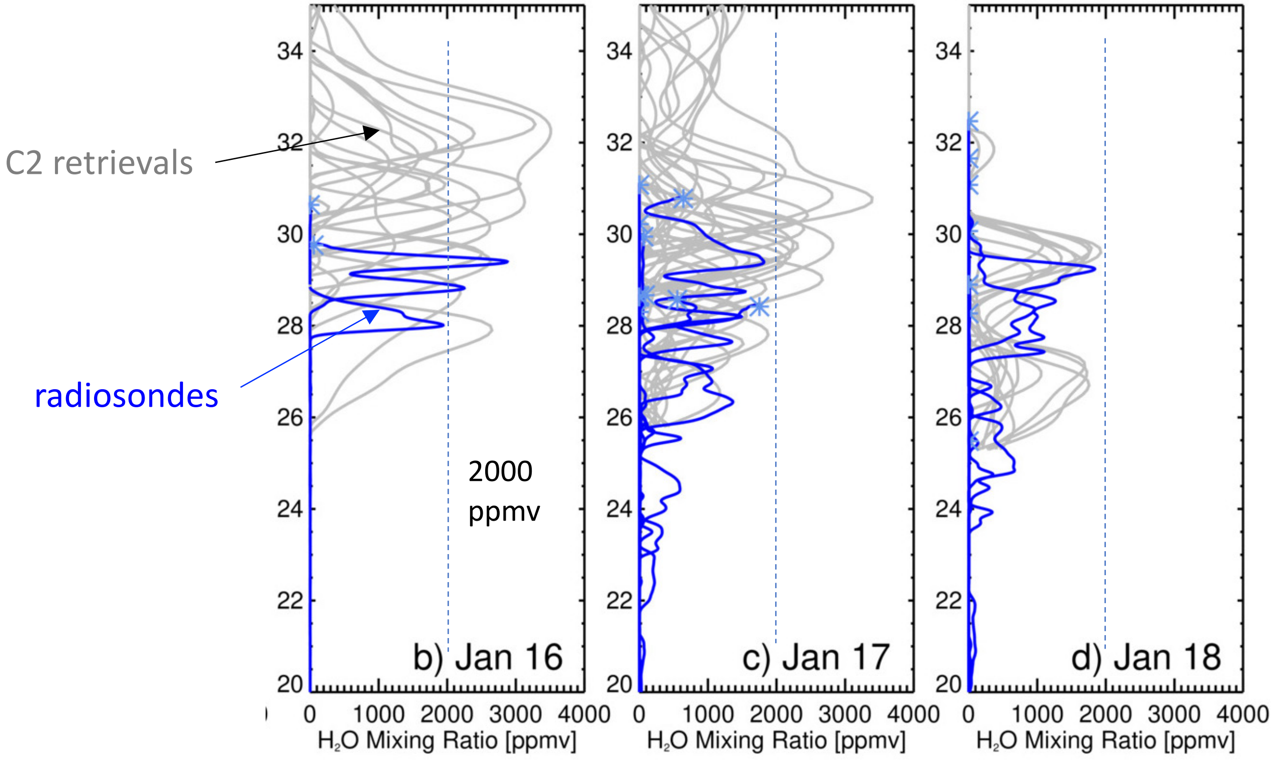


remote sensing
MDPI

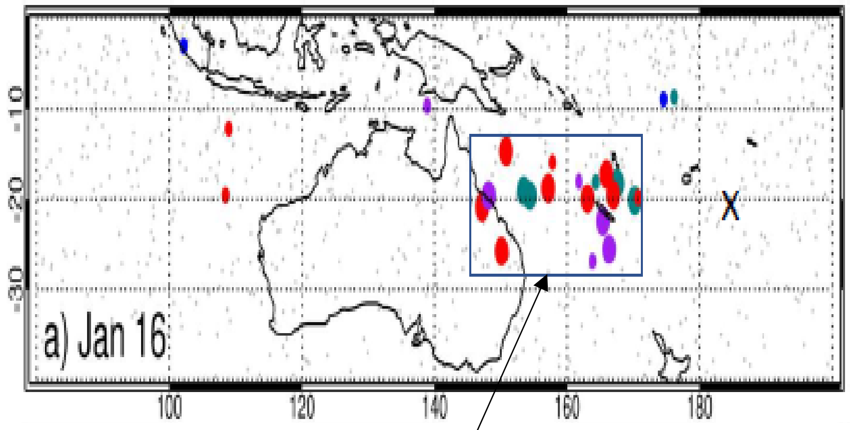
Article

Stratospheric Water Vapor from the Hunga Tonga–Hunga Ha'apai Volcanic Eruption Deduced from COSMIC-2 Radio Occultation

William J. Randel [1,2,*], Benjamin R. Johnston [2], John J. Braun [2], Sergey Sokolovskiy [2], Holger Vömel [1], Aurelien Podglajen [3] and Bernard Legras [3]



RO profiles with H_2O > 1000 ppmv 25-35 km



Estimated mass over 25-35 km: 110 Tg